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coefficient was less than about 4 cm^{-1} or less than about 3 cm^{-1} at a wavelength of 400 nanometers, the optical absorption coefficient was less than about 3 cm^{-1} or less than about 2.2 cm^{-1} at a wavelength of 410 nanometers, the optical absorption coefficient was less than about 2.5 cm^{-1} or less than about 2.0 cm^{-1} at a wavelength of 415 nanometers, and the optical absorption coefficient was less than about 1.5 cm^{-1} or less than about 1.0 cm^{-1} at a wavelength of 450 nanometers.

While the above is a full description of the specific embodiments, various modifications, alternative constructions and equivalents may be used. Therefore, the above description and illustrations should not be taken as limiting the scope of the present invention, which is defined by the appended claims.

What is claimed is:

1. A gallium-containing nitride crystal comprising:

a top surface having a crystallographic orientation within about 5 degrees of a plane selected from a (0001)+c-plane and a (000-1)-c-plane;

a substantially wurtzite structure;

n-type electronic properties;

an impurity concentration greater than about $2 \times 10^{17}\text{ cm}^{-3}$ of hydrogen;

an impurity concentration less than about $1 \times 10^{17}\text{ cm}^{-3}$ of oxygen;

an H/O ratio of at least 10;

an impurity concentration greater than about $2 \times 10^{14}\text{ cm}^{-3}$ of at least one of Li, Na, K, Rb, Cs, Ca, F, and Cl;

an optical absorption coefficient less than about 5 cm^{-1} at a wavelength of 400 nanometers;

an optical absorption coefficient less than about 4 cm^{-1} at a wavelength of 410 nanometers;

an optical absorption coefficient less than about 3 cm^{-1} at a wavelength of 415 nanometers; and

an optical absorption coefficient less than about 2 cm^{-1} at a wavelength of 450 nanometers;

wherein the gallium-containing nitride crystal is characterized by,

an absorbance per unit thickness of at least 0.01 cm^{-1} at wavenumbers of 3218 cm^{-1} , 3202 cm^{-1} , and 3188 cm^{-1} ; and

no infrared absorption peaks at wavenumbers between about 3175 cm^{-1} and about 3000 cm^{-1} having an absorbance per unit thickness greater than 10% of the absorbance per unit thickness at 3218 cm^{-1} .

2. The gallium-containing nitride crystal of claim 1, characterized by a carrier concentration n between about 10^{16} cm^{-3} and 10^{20} cm^{-3} and a carrier mobility η , in units of centimeters squared per volt-second, such that the logarithm to the base 10 of η is greater than $-0.018557[\log_{10}(n)]^3 + 1.0671[\log_{10}(n)]^2 - 20.599[\log_{10}(n)] + 135.49$.

3. The gallium-containing nitride crystal of claim 1, further comprising an impurity concentration of at least one of silicon and germanium between about $1 \times 10^{17}\text{ cm}^{-3}$ and about $3 \times 10^{18}\text{ cm}^{-3}$.

4. The gallium-containing nitride crystal of claim 1, wherein the carrier concentration is between about $3 \times 10^{17}\text{ cm}^{-3}$ and about $3 \times 10^{18}\text{ cm}^{-3}$.

5. The gallium-containing nitride crystal of claim 1, wherein the top surface has a diameter greater than about 10 millimeters and the crystal has a thickness greater than about 100 micrometers.

6. The gallium-containing nitride crystal of claim 1, comprising an impurity concentration of at least one of F and Cl between about $2 \times 10^{14}\text{ cm}^{-3}$ and about $5 \times 10^{17}\text{ cm}^{-3}$.

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7. A device comprising the gallium-containing nitride crystal of claim 1.

8. A gallium-containing nitride crystal comprising:

a top surface having a crystallographic orientation within about 5 degrees of a plane selected from a (0001)+c-plane and a (000-1)-c-plane;

a substantially wurtzite structure;

n-type electronic properties;

an impurity concentration greater than about $5 \times 10^{17}\text{ cm}^{-3}$ of hydrogen;

an impurity concentration between about $2 \times 10^{17}\text{ cm}^{-3}$ and about $4 \times 10^{18}\text{ cm}^{-3}$ of oxygen;

an H/O ratio of at least 0.3;

an impurity concentration greater than about $1 \times 10^{16}\text{ cm}^{-3}$ of at least one of Li, Na, K, Rb, Cs, Ca, F, and Cl;

an optical absorption coefficient less than about 8 cm^{-1} at a wavelength of 400 nanometers;

an optical absorption coefficient less than about 6 cm^{-1} at a wavelength of 410 nanometers;

an optical absorption coefficient less than about 5.5 cm^{-1} at a wavelength of 415 nanometers;

an optical absorption coefficient less than about 4 cm^{-1} at a wavelength of 450 nanometers;

an absorbance per unit thickness of at least 0.01 cm^{-1} at wavenumbers of approximately 3175 cm^{-1} , 3164 cm^{-1} , and 3150 cm^{-1} ;

no infrared absorption peaks at wavenumbers between about 3200 cm^{-1} and about 3400 cm^{-1} or between about 3075 cm^{-1} and about 3125 cm^{-1} having an absorbance per unit thickness greater than 10% of the absorbance per unit thickness at 3175 cm^{-1} .

9. The gallium-containing nitride crystal of claim 8, characterized by a carrier concentration n between about 10^{16} cm^{-3} and 10^{20} cm^{-3} and a carrier mobility η , in units of centimeters squared per volt-second, such that the logarithm to the base 10 of η is greater than $-0.018557[\log_{10}(n)]^3 + 1.0671[\log_{10}(n)]^2 - 20.599[\log_{10}(n)] + 135.49$.

10. The gallium-containing nitride crystal of claim 8, further comprising an impurity concentration of at least one of silicon and germanium between about $1 \times 10^{17}\text{ cm}^{-3}$ and about $3 \times 10^{18}\text{ cm}^{-3}$.

11. The gallium-containing nitride crystal of claim 8, wherein the carrier concentration is between about $3 \times 10^{17}\text{ cm}^{-3}$ and about $3 \times 10^{18}\text{ cm}^{-3}$.

12. The gallium-containing nitride crystal of claim 8, wherein the top surface has a diameter greater than about 10 millimeters and the crystal has a thickness greater than about 100 micrometers.

13. The gallium-containing nitride crystal of claim 8, characterized by,

an optical absorption coefficient less than about 4 cm^{-1} at a wavelength of 400 nanometers;

an optical absorption coefficient less than about 3 cm^{-1} at a wavelength of 410 nanometers;

an optical absorption coefficient less than about 2.5 cm^{-1} at a wavelength of 415 nanometers; and

an optical absorption coefficient less than about 1.5 cm^{-1} at a wavelength of 450 nanometers.

14. The gallium-containing nitride crystal of claim 8, characterized by,

an optical absorption coefficient less than about 3 cm^{-1} at a wavelength of 400 nanometers;

an optical absorption coefficient less than about 2.2 cm^{-1} at a wavelength of 410 nanometers;

an optical absorption coefficient less than about 2.0 cm^{-1} at a wavelength of 415 nanometers; and